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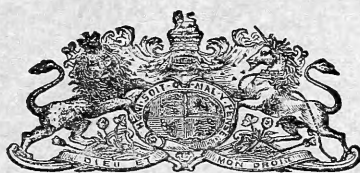
INDIAN MUSEUM NOTES.

ISSUED BY THE TRUSTEES.

VOLUME II.—No. 4.



THE LOCUSTS OF BENGAL, MADRAS, ASSAM, AND BOMBAY.



Published by Authority of the Government of India, Revenue and Agricultural Department.

CALCUTTA:

PRINTED BY THE SUPERINTENDENT OF GOVERNMENT PRINTING, INDIA.

1891.

Price One Rupee.

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INDIAN MUSEUM NOTES.

THE LOCUSTS OF BENGAL, MADRAS, ASSAM, AND BOMBAY.

[*With one plate.*]

A report has recently been issued on the subject of *Acridium peregrinum*, which is *par excellence* the locust of North-Western India. In gathering together the materials upon which this report was based, information was obtained concerning other locusts which have from time to time proved destructive in Bengal, Madras, Assam, and Bombay. The present report, therefore, is intended to record what has been ascertained about these other locusts. To complete the subject, a short *résumé* has been added of what is known of the chief locusts that are found in other parts of the world.

The principal sources of information have been the reports and specimens furnished by the Revenue and Agricultural Department of the Government of India and by the Agricultural Sections of the various Local Governments in India, but reference has also been made to the more important papers published in the United States, Algeria, and Europe, on the subject of locusts.

A short preliminary sketch of a portion of this paper was submitted in November 1889, since which date a good deal of fresh information has accumulated.

The writer takes this opportunity to acknowledge the help which has been most kindly afforded by Dr. Henri de Saussure in identifying species.

LOCUSTS IN BENGAL.

In Bengal, it is chiefly in the comparatively dry country to the west that locusts appear, though occasionally flights traverse the whole of Bengal and even penetrate into Assam. These flights are composed of insects belonging to very different species, and there are at least three distinct sources from which they come. In the first place, flights of *Acridium peregrinum* occasionally penetrate from the North-West frontier into Bengal. This was the case both in 1863 and 1890. An account of what is known of these flights is given in the report on *Acridium peregrinum*. Secondly, flights occasionally penetrate into Bengal from

the highlands of Southern India, and in these cases they probably belong to some of the various species which occasionally prove destructive to crops in the Madras and Bombay Presidencies and in the Central Provinces¹. This was probably the case with the flights of 1877 and 1878, notices of which are given below. Thirdly, flights are believed occasionally to arise locally². This is probably what happened in 1881, when a flight invaded the Manbhoom district from hills in Hazaribagh. No information has yet been obtained on the subject of the identity of these local species; they may, perhaps, in some cases have belonged to the species *Acridium succinctum*.

Whatever the origin of the flights, the injury done by them in Bengal has never been very extensive, and no special measures have been adopted against them. According to a report, dated 14th July 1883, by Mr. W. H. Grimley, low-class Mahomedans and Hindoos are said to store the locust, both for food and also in order to extract an oil believed to be useful in the treatment of gout and rheumatism, but upon the whole the pest is of no very great importance.

The following is an abstract of the records of the invasions of locusts other than *Acridium peregrinum* in Bengal :—

In 1862 locusts visited Monghyr and did considerable damage to the crops (Report, dated 26th June 1890, by the Commissioner of Bhagulpore and the Santhal Parganas). We have no clue to the identity of this locust, except that in this, as in the following instances, the year was not one in which *Acridium peregrinum* was prevalent in its regular breeding grounds in North-Western India; so, it is pretty certain that the species was not *Acridium peregrinum*. In 1865 locusts passed over Manbhoom, without, however, doing serious damage to the harvest (Hunter's Gazetteer); they also appeared in this year in Durbhunga (Mr. W. H. Grimley's Report, dated 14th July 1883).

In 1873 they are said to have passed over part of the Burdwan district (Commissioner of Burdwan's Report, dated 28th April 1890). In 1877 they visited Monghyr and did considerable damage to the crops (Commissioner of Bhagulpore and the Santhal Parganas' Report, dated 26th June 1890); a flight was also observed in this year in the neighbourhood of Patna (Mr. Scott's Note), and a specimen obtained from it on 1st July

¹ The chief of these species are said to be *Acridium succinctum*, *Pachytylus cinerascens*, *Acridium aeruginosum*, *Acridium melanocorne*, *Tryxalis turrata*, *Hieroglyphus furcifer*, *Caloptenus erubescens*, *Caloptenus eruginosus*, *Cyrtacanthacris ranacea*, *Oxya furcifera*, *Euprepocnemis bramina*, *Oxya velox*, and *Chrotogonus* sp.

² With regard to the origin of locusts in the Durbhunga district, the Commissioner of Patna reported (16th July 1890) that the swarms were said to come from the Darjeeling Hills, though some authorities were of opinion that they breed in the large tract of grass jungles that fringe the river Ganges. The supposed inability of these local species to cross any large body of water is noticed in this report.

1877 by Mr. Scott has recently been identified by Dr. Henri de Saussure as closely allied to the species *Acridium succinctum*. In 1878 locusts which had probably strayed from the flights then prevalent in the Madras Presidency, appeared in the Patkour subdivision of the Santhal Parganas from the south, but did not alight (Commissioner of Bhagulpore and the Santhal Parganas' Report, dated 26th June 1890). They also appeared in small numbers in Orissa, but did no appreciable damage (Babu C. N. Ghose's Report, dated 20th February 1890), and passed over Chumparan (Mr. W. H. Grimley's Report, dated 14th July 1883). In 1881 a flight of local origin appeared in Manbhoom and did some slight injury. The following is an extract from a report, dated 14th July 1883, by Mr. W. H. Grimley on the subject :—

“The subdivisional officer of Gobindpore, in the district of Manbhoom, reports that in June 1881 a swarm of locusts visited the subdivision, extending over an area about ten by five miles, and about a quarter of a mile high. They are said to have emerged partly from the Lagoo Pahar, and partly from the Paresnath hill, in the Hazaribagh district. Considerable numbers alighted on the young *dhan* seedlings, Indian-corn and *gondlee*, which had just sprouted, and destroyed them. Much damage is said to have been caused by the insects, but they did not stay for more than four or five hours.” The insects were “about four inches long with heads and wings of a red colour. A large number were destroyed by the people, and some were eaten up by the kites and crows, also by low-caste aborigines. They are said to possess the flavour of shrimps or lobsters.”

LOCUSTS IN MADRAS.

Both in 1889 and 1890 flights of *Acridium peregrinum* from North-Western India penetrated into the Madras Presidency, and did slight damage over considerable areas; generally speaking, however, the locusts, which occasionally prove destructive to crops in Madras, are of more local origin. There does not appear to be any one species which is invariably complained of, but in years of drought numerous species, which are ordinarily present in small numbers, multiply so as to injure the crops, some of them, however, being much more destructive than others. An account of what has been ascertained about the flights of *Acridium peregrinum*, which penetrated into the Madras Presidency in 1889 and 1890, has been given in the report on that species. The following is a summary of what is known of the other species of locusts that have proved injurious in the Madras Presidency :—

In 1866, a year of scarcity, locusts appeared in one of the villages of the Chingleput district, in the Madras Presidency, and did some damage (Mr. W. R. Robertson's Report, dated 23rd April 1883). No information has been obtained as to the identity of this insect.

In 1878, the last year of the great South Indian famine, locusts invaded the whole of the Madras Presidency, not generally doing a great amount of injury, though in some cases the injury was sufficient seriously

to increase the distress caused by the famine. The young locusts began to appear in January, and were found in great numbers in different districts from that date on till September and October, the earlier swarms being found in the west and south of the Presidency, and the later ones in the north and east. The winged locusts were first observed in the end of March and beginning of April in the south-west (Wynaad and Nilgiris), and they afterwards spread over the Presidency to the east and north, not finally disappearing in the north-east until about November and December. They were supposed, at the time, to have originated locally in hills and waste lands in different parts of the Presidency. The evidence, however, seems rather to point to the locusts having started, in the early part of the year, from the Wynaad and Nilgiri Hills, in the south-west, and thence to have worked their way, with the prevailing wind, over the Presidency to the north and east, occasionally stopping to feed or to deposit their eggs in the ground; for it is otherwise difficult to account for the fact of their appearing so much earlier in the south-west than in the north-east. Little is known of the life-history of the insects, but it may be noticed that locusts were observed pairing in the Salem district in the latter part of June, and also that the young locusts, which were found in the early part of May in the Udamalpet taluq were supposed to be the offspring of the large flights of winged locusts which had appeared in the preceding February in the same taluq. The connection between the autumn broods of young locusts and those which appeared in the early part of the year has not been made out satisfactorily.

Of the measures adopted against these locusts, the most successful seem to have been;—the destruction of the swarms of young wingless locusts by driving them into lines of burning straw; the preventing the flights of winged locusts from settling in the fields by lighting fires, beating drums, and waving branches and cloths in the air, as soon as a flight appeared; and the driving of the winged locusts out of the fields, when they had already alighted, by beating through the crops. It is said that in cases where winged flights were driven persistently through a number of villages, without being allowed to settle, the locusts perished without doing injury. The above account of the Madras locust invasion of 1878 is chiefly taken from the official reports preserved in the Proceedings of the Revenue and Agricultural Department of the Government of India. With regard to the identity of the insects concerned in the Madras locust invasion of 1878, nothing seems to have been ascertained at the time of the invasion, though the insects were spoken of in one of the reports as belonging to the species *Locusta migratoria*. This, however may possibly have been due to the fact that the locust of Central Europe is often referred to in old entomology books under this antiquated name; much importance, therefore, cannot be attached to the identification, and

the only clue which we possess lies in the specimens preserved in the collections of the Central Museum, Madras. From this museum a set of specimens, which are supposed to represent the Madras locust of 1878, have been kindly furnished by Mr. Edgar Thurston. They have been identified by Dr. Henri de Saussure and prove to comprise no less than six very distinct species, which are as follows: (1) *Acridium æruginosum*, Burm., represented by five or six specimens, which vary a good deal in the arrangement of the wing markings, (2) *Acridium melanocorne*, Serv., var., (3) *Tryxalis turrita*, Linn., (4) *Mecopoda* sp., (5) *Euprepocnemis* sp., represented in each case by one or at most two specimens, (6) a specimen, in a very poor state of preservation, which belongs either to the species *Pachytylus migratorius* or to *Pachytylus cinerascens*.

In July 1890 locusts were noticed in the Ganjam collectorate, the following being the Collector's report to the Revenue Board, Madras, on the subject:—

“I have the honour to inform you that on the 24th instant I visited Purushottapur in order to see whether anything could be done to destroy the locusts reported to be doing so much mischief there.

“I had two large ‘bag nets’ made of bamboo matting, 15 feet long; and hoped that I might have been able to do something with them; but am sorry to say that all attempts ended in failure. I also attempted to drive the insects into trenches, but without success. The reason for the failure is, that the insects, which are of four or five different kinds, succeed in evading the net or the drive, the large ones by flying away when approached, the smaller ones by dropping to the ground and clinging there, so that nothing would remove them which would not at the same time root out altogether the crop. The number of large brown insects which seem to be really locusts is comparatively small, the great bulk are small brown and green grass-hoppers, which are in myriads. A great deal of damage has undoubtedly been done. The pest extends over about 10 square miles, chiefly in the Pubbakhandam mutah of the Berhampore taluk. Of one hundred and four villages (including Agraharams and Mokhasas) in the mutah, fifty-five are more or less affected and ten have suffered seriously.

“All the villages most affected are near the Dalibhillo Tampara, the embankment of which breached in the floods of last year and has not yet been repaired, in consequence of which a large expanse of ground, usually under water, has been lying dry. The ryots report that the insects first made their appearance in the vicinity of the Tampara, and I think it probable that they were brought out in unusual quantities owing to the unusual extent of dry ground there. Steps are being taken now to repair the embankment, and I trust that next year the Tampara will not afford so convenient a breeding ground, and that the insects will either not re-appear or do so in diminished numbers.”

Specimens were forwarded to the Indian Museum and were found to consist of (1) ten adults and eight larvæ of *Pachytylus cinerascens*¹, (2)

¹ These specimens were identified by Dr. Henri de Saussure; the species is so closely allied to *Pachytylus migratorius*, which is the common migratory locust of Central Europe, that it is very doubtful as to whether the two forms are separable. Koppen indeed (*vide* Zool. Record, 1872, page 398) considers that *P. cinerascens* is only a variety of

four specimens of *Tryxalis turrita*, Linn., (3) one specimen of *Oxya velox* Burm., (4) one specimen of a species which is probably *Epacromia dorsalis* Thumb., (5) one larva of a grass-hopper probably belonging to the genus *Edalus*. Of these the immature specimens are probably the "small brown and green grass-hoppers," alluded to by the Collector as present in myriads, while the full-grown specimens of *Pachytylus cinerascens* are likely to have been the "locusts" mentioned as present in comparatively small numbers. Now, *Pachytylus cinerascens* is one of the chief migratory locusts of Europe, where it sometimes does a great deal of damage. The insect is essentially an inhabitant of the temperate zone, and this would make it appear probable that its permanent breeding-ground lies somewhere in the Nilgiri or other hills, whence it might easily be carried upon the south-west monsoon across the presidency. The presence of nearly full-grown larvæ shows that the original flight must have remained in the district sufficiently long to have laid their eggs, and for the eggs to have hatched, and for the larvæ to have passed through most of the early stages, a process which probably occupied some months. In the Palæarctic zone *P. cinerascens* is said to lay its eggs in the autumn, the young hatching out in the following summer, but we are as yet entirely in the dark as to the habits which the insect acquires when it passes out of a temperate climate into a tropical one.

LOCUSTS IN ASSAM.

Assam is not generally troubled by locusts, though in the cold weather of 1890-91 a stray flight of *Acridium peregrinum* from North-Western India penetrated into it. In 1879 also both the autumn and winter crops in Nowgong were reported by the Director of Agriculture to have been largely destroyed by locusts, which were said to have come from the tall grass jungle at the base of the Khasi and Mikir Hills, where they breed permanently. Nothing is known of the identity of this

P. migratorius, and the specimens of the two forms in the Indian Museum (as determined by Dr. Henri de Saussure) seem to point to this being the case. According to the synopsis given on page 119 of Dr. Saussure's *Prodromus Edipodiorum*, in *P. cinerascens* the male is smaller than the female, the punctation on the pronotum is somewhat coarse, the notch in the carina is well marked, and the teeth on the posterior femora are large; while in *P. migratorius* the male is much the same size as the female, and the punctation on the pronotum, the notch on the carina, and the teeth on the posterior femora are less marked. To these characteristics Mons. Frey Gessner adds that the carina on the thorax of *P. cinerascens* is elevated into a well-marked ridge, while that of *P. migratorius* is much less distinct. These characteristics however seem, in the absence of any well-marked geographical boundary between the areas in which the two forms occur, to be of scarcely sufficient importance to justify their separation into two species, this being especially the case, as Dr. de Saussure writes that the females of the two forms are often almost indistinguishable.

locust, though it may possibly have been the insect *Phymatens miliaris*, which was sent to the Indian Museum in September 1890 by General Collett with the information that it was common in the neighbourhood of Shillong. The following is taken from a report, dated 15th February 1883, by the Director of Agriculture in Assam :—

“I spent three weeks marching in the Nowgong district, and visited most of the district, except the hill tracts. The *Kakotiphoring*, or Paper grass-hopper, as the locust is called, is very well known. It is said to attain a length of six to seven inches. It breeds in the tall reed and grass jungle, especially in the jungle at the foot of the hills along the south of the district (the Khasia and Mikir Hills). The time of the appearance of the insect is in the early spring, and it continues to feed till July.

“Local visitations of locusts are common enough. I found it generally stated that they took place every two or three years. But one general invasion was well remembered everywhere; the date was 1879: it began early and ended late, so as to include both mustard and rice in the area of devastation. The mustard ripens in January.

“The direction in which the locust swarms moved was somewhat different in different places. Near the Khasia and Mikir Hills they seemed to come from the south, *i.e.* from the submontane jungle. In the Chapari Mahals, between the Kalang and Brahmaputra, the direction of their course was eastwards. They seem to have moved with great regularity from west to east along this tract, a distance of some 50 miles. The ryots, moved perhaps by rumours of the Afghan war, which had penetrated thus far, told one another that they came from Cabul. Their numbers were such that the reeds and grass of the jungle were bowed down by their weight when they alighted, and they made a clean sweep of all the fields in their way. The Mikirs and Lalungs eat locusts after parching them in the fire. Locusts can commonly be had in the month of Bohag (April-May). The only remedy adopted against locusts is one which the people appear to have invented for themselves. They sprinkle the threatened crops with water in which salt has been dissolved, and in which onions have been steeped. This remedy is said to have been effectual in 1879, after some time; probably the locusts would have moved on in any case.”

LOCUSTS IN THE BOMBAY PRESIDENCY, EXCLUDING SIND.

In the autumn of 1890 flights of *Acridium peregrinum* from North-Western India penetrated into the Bombay Deccan and Konkan, and did slight damage over considerable areas. An account of these flights has been given in the report on *Acridium peregrinum*, and we are now chiefly concerned with the locusts which invaded the Presidency in 1882-83, though it should also be noticed that, according to Hunter's Gazetteer, locusts appeared in 1878 in Kolaba and damaged the cold weather crops of 1878-79, nothing further, however, being recorded about them.

In 1882-83 locusts proved destructive throughout the whole of the Bombay Deccan and Konkan, and though the identity of the insects concerned was not altogether definitely ascertained, the history of the invasion was very completely recorded in numerous official reports. The

sections, therefore, on the history of the invasion and on the remedies adopted have been taken, much of them, *verbatim* from the reports of the Bombay Government by Mr. J. Nugent, as recorded in the Records of the Revenue and Agricultural Department of the Government of India. The section on the life-history of the insect is from a report by Mr. Hatch, as reprinted in the *Indian Forester*, Volume X.

In May and June 1882 locusts were noticed in the south-west of the Presidency (Dharwar and Kanara Collectorates), but they attracted little attention, as such swarms are annual visitors of the Kanarese forests, and neither in Kanara nor in Dharwar did they cause any material injury. With the setting in of the south-west monsoon however, they spread in flights over the Presidency, to the north and north-east (Satara, Poona, Nasik, Ahmednagar, and Khandesh), and early in the rains proceeded to lay their eggs and die. These eggs hatched in the end of July, or beginning of August, and the young locusts did a large amount of damage, over a wide area, through the months of August and September. In the early part of October, with the setting in of the north-east monsoon, the young locusts, which had by this time acquired wings, took flight and travelled with the prevailing wind in a south-westerly direction, doing some injury in the Poona collectorate as they passed. They then struck the Western Ghâts, and spread slowly over the Konkan in November, and thence travelled into the Native State of Sawantwari, and the Kanara district. During the remainder of the cold season and the hot weather (December 1882 to the end of May 1883) the flights clung to the line of Ghâts, occasionally venturing inland into Belgaum, Dharwar, the Kolhapur state, and Satara, and devouring the spring crops in the coast districts, but ordinarily returning to the vicinity of the hill ranges. With the commencement of the south-west monsoon however, in the latter part of May 1883, the flights began to move in a north-easterly direction, as they had done the preceding year, but in larger numbers.

At the commencement of the rains they began to alight in vast numbers over an immense tract of country comprising the six Deccan collectorates of Sholapur, Poona, Khandesh, Ahmednagar, Satara, and Nasik, and also in the three coast collectorates of Ratnagiri, Kolaba, and Thana. They deposited their eggs, and died, and early in August the young locusts hatched out in countless numbers, but were apparently more backward and possessed of less strength and stamina than were those of the preceding year. The unusually heavy rainfall killed vast numbers of these in different parts of the country, and elsewhere the insects seemed stunted and feeble, and grew but slowly. They were destroyed in vast numbers by the vigorous measures initiated by the officials, and were also said to be diseased and attacked by mites and *nematode* para-

sites. As late as November the mass of the young locusts appeared unable to fly and made no general movement to the south-west, as they had done the year before. The invasion was, in fact, at an end, and though (according to Hunter's Gazetteer) swarms appeared in Sawantwari in 1883-84, no further injury of a serious nature seems to have occurred.

The injury occasioned to the rain crops by the locusts was very considerable, over a great portion of the Deccan and Konkan both in 1882 and 1883. But though some relief works were started, especially in the coast districts, it was found, at the end of the invasion, that the abundance of the cold weather crops had compensated to so great an extent for the injury occasioned to the rain crop, that no widespread injury had been occasioned.

The life-history of the locust.

Mr. Hatch describes the life-history of the locust, as observed in the Konkan, as follows¹:—

"In the Konkan locusts coupled in great numbers between the 15th May and the 15th June 1883, and died off naturally immediately after the eggs had been deposited. The eggs are deposited mostly in flat and gently sloping land of soft friable soil, rocky and sandy soil being avoided, and land which has been ploughed up, and the lee side of banks, where the soil has accumulated, are mostly selected. The eggs are piled in a small cylindrical hole, parallel to its sides, and are attached to one another by some cohesive siccable substance. Filling the mouth of the hole is a plug, consisting of a soft fibrous substance, and below it the eggs, arranged as described, averaging 70 in each hole. The holes are from 1·5 to 2 inches in depth, and in a good locality four might be found in a span. They are not easily visible, but when one is found, others are generally near it. Brushing off the loose dust and digging here and there facilitates search.

"The eggs themselves are of a dirty ochre colour, in length ·2 to ·3, and in diameter ·05 to ·08 of an inch, rounded in section, with a slight curve, and tapering very slightly towards the rounded ends. . . . When fresh, the contents of the eggs are of a dirty orange colour, liquid but slightly viscous, with a somewhat acrid taste. The envelope apparently consists of two layers, the outer one coloured and tough, and the inner one white and fragile. When broken, the eggs give off an odour like a broken root. As the eggs approach maturity, they assume a distinctly greenish hue, and the young locust bursts the shell down the middle on issuing into life. I experimented on some eggs by placing them in damp and very damp soil, but the water did not affect the hatching.

"The young locusts appeared in myriads in my district (Chiplum taluka) between 1st and 20th August, so that the period the eggs required to hatch was a little more than two months, say seventy days.

"The young locusts vary somewhat in colour, most being a dullish light green, some light green, but hardly verdant, and a few almost white and only tinged with green. A few minutes after hatching they are strong enough to jump The antennæ are darksome and short, whilst on the thigh cases small black spots, and on the upper side of the abdomen a faint black line, are just visible.

"The young locusts generally cast their slough for the first time about 15 days after birth, and in their new skin the black line and spots become darker and the green colour of a deeper hue. They now leave the grass land and seek the shelter of the crops, and are in length ·8 of an inch.

¹ From his report, as reprinted in the *Indian Forester*, vol. X, p. 425.

"After another interval of 15 days they again cast their slough and enter on the third state. In this the black line becomes very intense, as also do the spots, which lengthen and form the so-called 'Koranic verses'—they do show a certain similitude to some letters of the Arabic alphabet vernacular. They are now 1·2 of an inch in length.

"They enter the 4th stage by casting their slough after another 15 days, and assume, including the antennæ, a yellow colour, which, towards the end of the stage, becomes pinkish grey. The black line and the 'Koranic verses' are now very intense in colour, and the insect attains the length of 1·6 of an inch.

"A great transformation is witnessed on entry into the 5th stage after 15 more days. The female is now 2 inches long, whilst the male is somewhat less. The colour of the head, prothorax, and abdomen is a grey or drab, speckled on the prothorax, and darker along the upper side of the abdomen. The ringed antennæ are a deep yellow, the eyes chestnut and striated, whilst for the first time appears an oblong mark under each eye, indigo green in colour, and bordered on each side by yellow. The Arabic letters have now disappeared, whilst the spots on the thigh cases are obsolescent. The young wings, too, now first appear. At first very small, they grow during the period of this stage—20 days. The contents of the wing-sprouts are at first liquid, and the young wings may be seen forming within the semi-transparency. When they are fully formed, the insect is of a dark brownish grey colour, whilst on the prothorax and elsewhere may be distinguished the colouring of the next stage.

"In its 6th and perfect stage the insect presents a brilliant appearance. The female is now 3 inches, and the male $2\frac{1}{2}$ inches, in whole length, from head to tips of wings which overlap the abdomen by .5 of an inch, and are rounded. On casting the slough, the wings dry and unfold, and the body of the insect, at first soft and moist, gradually hardens in the sun. The antennæ are .8 inch in length, and of a bright yellow colour; the head is a brownish yellow, and the eyes, finely striated, are of a deep chestnut. The prothorax is alternately banded with a bright yellow and a rich brown, parallelwise to the body, and the legs are of an ochreish hue. Along the upper rim of the femur runs a deep brown stripe, and the knee-caps are of the same colour. The tibia, tarsus, and foot are a bright ochre, and the first is armed with 8 black-tipped spurs on the outside and 11 on the inside, while there are a pair of spurs on each side of the ankle-joint and on each side of the foot. The outer wings, or wing cases, have the colours on the prothorax extended to them, and on the back they form a flat surface, tapering to the extremity. They are strongly veined and finely reticulated, and towards the extremities are irregularly brown marked. The inner wings, which are expansive, are hardly coloured. The abdomen is a light brown, darker along the ridge, and in the female there are four spiky processes at its extremity, the upper pair curling up and the lower pair downwards. In the male the lower pair is replaced by one spiky process, larger and stronger.

"The locust now packs with its kindred, and they form the swarms which ravage the country. After a month or so they assume a red tinge, which gradually deepens and continues until their death, which takes place after the sexual function has been performed in May or June. The proportion of males to females appeared to me about 1 in 6.

"The whole life of the insect, including the egg-period, is exactly one year."

Various methods were employed in the Bombay Presidency in 1882-83 to destroy the locusts, which were to a large extent Remedies. kept under by the energetic measures taken against them. The Cyprus screen system,¹ was found utterly inapplicable and

¹ The Cyprus screen system consists in erecting a long line of screens, each two to

had to be abandoned. The search for eggs also was not found successful as a means of destroying the pest. A plan was tried of marching lines of beaters, armed with bundles of twigs through the fields beating the ground so as to crush the young locusts. This was to some extent successful in short grass, but could not be made use of with growing crops. The plan of dragging country blankets rapidly over a field where locusts were to be found, and squeezing up the cloth every few yards to kill the insects which had been caught, was found useful in bushy tracts, but required, for its successful working, a good deal of activity and intelligence. The most successful method consisted in dragging over the fields a capacious bag, five or six feet deep by eight or ten feet long and much like a huge bolster case, but open at the side, instead of at the end. This was held by two men, one at each end, and was run along over the grass or young crops, to catch the locusts, which tumbled in, and, being unable to escape, could, from time to time, be killed by twisting up the bag. This was found to be a simple and easy means of destroying the locusts, and the people took to it readily all over the locust-affected area. Little or no injury was done to the crops by the men working it, and millions of insects were killed.

With regard to the numbers destroyed during the locust invasion, the Collector of Nasik reported the destruction in his collectorate alone of some forty-five tons of locusts, which he estimated must have represented about a thousand millions of individual locusts. Similarly in the Satara collectorate one hundred and eighty tons were reported to have been destroyed by the local officials. The numbers destroyed in these two collectorates were no doubt greater than in most of the collectorates which suffered from the locusts, but the figures give some idea of the extent of the invasion.

With regard to the identity of the locust of 1882-83 Dr. Macdonald in his report, reprinted in the *Indian Forester*, Vol. X, advanced the supposition that the insect was *Acridium peregrinum*, and this name was adopted in most of the official reports which subsequently appeared. There seems, however, to be conclusive proof that the insect belonged to some other species. In the reports, both of Lieutenant Colonel Swinhoe and

three feet high, in front of an advancing swarm of young wingless locusts, pits being dug at intervals, close to the screens and at right angles to them, on the side towards the advancing swarm, the object being that the young locusts, on arriving at the screens, may turn to the right and left, and thus pour into the pits, where they can be destroyed. The chief advantage of the screen system is, that it enables a series of pits, dug at intervals, to take the place of the continuous trench that would otherwise be necessary to catch the whole of a swarm. The material hitherto chiefly used for the screens has been cloth, bound along the top with a strip of slippery oilcloth about four inches wide to prevent the locusts climbing over, but smooth mat screens are likely to be cheaper for use in many parts of India. The pits are usually furnished with overhanging zinc edges to prevent the locusts escaping.

of Lieutenant Colonel Bradford, the locust of Rajputana, which is undoubtedly *Acridium peregrinum*, is spoken of as distinct from the Bombay locust of 1882-83. *Acridium peregrinum* has been shown to be essentially the inhabitant of sandy deserts, while the Bombay locust of 1882-83 originated in the tropical forests of the Western Ghâts. The habits also of the Bombay locust of 1882-83 differed materially from those of *Acridium peregrinum*, in that the young wingless larvæ of *Acridium peregrinum* can be readily driven into traps, while those of the Bombay species entirely declined to be destroyed in this manner. Again, specimens said to be "locusts" were sent from the Bombay Presidency in 1883 to the well known entomologist Mr. F. Moore, who identified them as belonging to no less than five species, namely:—*Acridium succinctum*, *Caloptenus erubescens*, *Caloptenus caliginosus*, *Cyrtacanthacres ranacea*, and *Oxya furcifera*; *Acridium peregrinum* being unrepresented, a circumstance which is not likely to have occurred if this had been the species which was at that time swarming over the Presidency. Again, at a meeting of the Entomological Society of London, held on the 4th of April 1883, Mr. W. F. Kirby, of the British Museum, exhibited specimens of a locust which he identified as *Acridium succinctum* and which he had received from Mr. T. Davidson, who stated that it was the species which had lately been destructive in the Deccan and other parts of India. In the absence, therefore, of actual specimens, which do not seem to have been preserved, it may be concluded as most probable that while numerous species of Acrididæ may have been present in great numbers in the Bombay Presidency in 1882-83, the insect chiefly responsible for the injury to the crops was *Acridium succinctum*, which, therefore, would be the one spoken of by most of the observers, who, from their reports, seem to have noticed but one kind of insect.

LOCUSTS IN OTHER PARTS OF THE WORLD.

Many species of Orthoptera occasionally increase vastly in numbers, so as to cause serious injury to agricultural crops; and there are, in different parts of the world, certain species, which are known distinctively as *Locusts*, and which possess this habit to a remarkable degree, often migrating in swarms which devour the crops over wide areas of country. Migratory locusts usually breed permanently in tracts where the vegetation is sparse. In years when they increase excessively, they descend in flights from their permanent breeding-grounds, upon cultivated districts, where they destroy the crops, lay their eggs, and maintain themselves for a limited period, but are unable to establish themselves permanently, usually disappearing in the year following the invasion, to be succeeded, after an interval of years, by fresh swarms from the permanent breeding-ground.

Generally speaking, the life circle of a locust extends through one year, in which period it passes through its various stages of egg, young wingless larva, active pupa, and winged adult which lays the eggs that are to produce the next generation, the only recorded exception being *Acridium peregrinum*, which is believed to pass through two generations in the year in India.

The eggs are laid in little agglutinated masses in holes which the female bores with her ovipositor in the ground. In temperate climates the eggs are usually laid by the end of summer, and the parent locust dies before the winter commences, the eggs remaining in the ground during the winter months, and hatching out in the following spring. In sub-tropical countries, where there is but little winter, the winged locusts live on through the cold season and do not die off until the following spring, when they deposit their eggs. In this case the eggs hatch after lying in the ground for about a month. In both temperate and sub-tropical regions alike, the young wingless locusts, on emerging from the eggs in the spring or early summer, feed voraciously and grow rapidly for one or two months, during which period they molt at intervals, finally developing wings and becoming adult. The adult locusts fly about in swarms, which settle from time to time and devour the crops. The damage done by locusts is thus occasioned, first, by the young wingless insects, and afterwards by the winged adults into which the young transform after a couple of months of steady feeding.

The following are the chief species of locusts found in different parts of the world other than India:—

Pachytylus migratorius, the chief migratory locust of Europe, occurs especially in Eastern Europe and Southern Russia, also in Central Asia, Siberia, North China, Japan, Fiji Islands, New Zealand, North Australia, Mauritius, Madeira, and possibly in South Africa, very little, however, being known about its distribution in the Southern Hemisphere (Mc Lachlan: article *Locust*, Encyclopædia Britannica). It may be looked upon as the chief locust of the temperate zone, excluding America. An elaborate account of this species in South Russia is given by Köppen (Horæ, Soc. Ent. Ross. iii, pp. 89—246; reviewed in Zool. Record, 1867, p. 457). From eggs laid in the autumn the larvæ hatch in the spring (April and May), and molt four times before they become adult. The larvæ band themselves together and move in search of nutriment, feeding chiefly on graminæ, and doing a vast amount of damage. The imagos emerge about July, copulate soon afterwards, and oviposition extends from August to October. Each female copulates and oviposits about three times, at intervals of about a month; each time laying from 50 to 90 eggs, in a hole bored by her horny ovipositor in the soil. This hole is about $1\frac{1}{2}$ inches deep and is lined with frothy matter, which hard-

ens into a case for the eggs. The eggs have been found to withstand as low a temperature as 26° F. below zero. The dry steppes constitute the chief haunts of the locusts, which avoid damp places. The females generally oviposit in solid virgin soil, and seldom visit ploughed land for this purpose. Köppen is of opinion that the countries in which the swarms are seen are also, generally speaking, the countries of their origin.

Pachytylus cinerascens, Fabr., and *Ædipoda tatarica*, Motsch., which have been described by different authors as distinct from *P. migratorius*, are considered by Köppen to be but varieties of one and the same species (Horæ, Soc. Ent. Ross. iii, 1867). *P. cinerascens* is the form which has usually appeared in England and Belgium, in the latter of which countries Köppen notices that it probably breeds (Zool. Record, 1872, p. 398). It also occurs in India 'vide pp. 101 to 104 on Locusts in Madras).

Pachytylus pardalinus has been described as destructive in South Africa (Trans. Soc. Afr. Phil. Soc. i, p. 193, 1880).

Pachytylus stridulus, *Ædipoda vastator*, *Stauronotus vastator*, and *Pezotettix alpina* have been noticed amongst other locusts as occasionally destructive in Southern Russia, especially when associated with the common migratory species *Pachytylus migratorius* and *Caloptinus italicus* of that region (Köppen, Horæ, Soc. Ent. Ross. iii, 1867).

Caloptenus spretus, the Rocky Mountain locust (see Reports of United States Entomologists—Riley, Packard and Thomas,—Washington, 1877-79), caused injury, between the years 1874 and 1877, estimated at 200 million dollars. It breeds permanently only in a broad and comparatively barren region in the north-west of America, whence the invading winged swarms swoop down upon the fertile plains of the south and south-east, not appearing in the Mississippi valley until the latter part of July or the beginning of August, when wheat, barley and oats have generally reached perfection and been harvested. This, it is reported, renders it possible to prevent serious injury by relying chiefly on these crops when there is reason to fear incursions. On arrival the locusts devour everything green to be found, until they deposit their eggs and die in the autumn. From these eggs are produced in the spring vast hordes of young which devour everything green they can find, travelling along the ground (not having yet acquired wings) from the fields they have exhausted to fresh ground. They may be destroyed in vast numbers by systematic rolling, collecting by hand, by drawing bags over the field, &c., and their advance may be prevented by digging ditches in front of them with a streak of tar at the bottom, and also by driving them into heaps of straw to be then burnt, the trees being protected by bands formed of poisonous or impenetrable substances. When the larvæ are full-fed and acquire wings they rise up, by this time followed by hosts

of insect parasites (Tachinæ, Ichneumonidæ, &c.), and weakened by disease, and make their way more or less directly towards their permanent breeding-grounds; they perish by millions on the road, so that but few ever reach their home, in the high and barren north-west, where alone they are able to propagate permanently. They leave (it is reported) a great part of the country sufficiently early to allow of corn of rapid growth being produced after their departure, and succeeding swarms avoid the parasite-stricken districts which their immediate predecessors have deserted. Hogs, poultry, and all kinds of birds, besides various insects, destroy vast numbers of the locusts; and as they can only exist permanently in the comparatively barren north-west, it is supposed that when this breeding-ground is irrigated and settled, the locusts will gradually be exterminated.

Caloptenus italicus occurs on the European side of the Mediterranean (Italy, Austria, &c.); it is also found in North Africa and South Russia (Verz. Zool. Bot. Ges. Wien. xviii, p. 930; Bull. Ent. Ital. xiii, p. 210). It has been reported as destructive.

Stauronotus cruciatus has proved injurious in Italy and Sicily (Bull. Ent. Ital. xiii, p. 210). It also periodically invades Cyprus and the Troad (Proc. Ent. Soc. Lond. 1881, pp. xiv & xxxviii; also, Brown:—Report on the Locust Campaign of 1885-86 in Cyprus).

In Cyprus the locust is indigenous to the island. The young hatch out about the middle of March, and take about six weeks to become adult, when they acquire wings, take flight, and soon afterwards copulate and oviposit. The eggs are laid in uncultivated rocky ground, ploughed land and light soil being avoided. Each egg-pod contains about 33 eggs. Some damage is done by the winged swarms, which, however, generally disappear by about the middle of June, the eggs remaining in the ground until about the following March, when they hatch.

Serious loss is often occasioned by the locusts, and of late years a regular warfare has been waged against them by the Government of the island. The following was found to be the most satisfactory method of destroying them: Cloth-screens, about three feet high and bound at the top with a strip of oilcloth to prevent the locusts from climbing over, were erected in front of the advance of the young locusts, pits being dug at intervals close to the screens and at right angles to them on the side towards the locust swarm, the edges of the pits being protected by frames made of cloth and wood, with zinc edge arranged to prevent the young locusts from escaping from the pits. A swarm, on arriving at the screen, was found invariably to turn right and left along it, apparently endeavouring to go round it, the young locusts thus poured in vast numbers into the pits dug to receive them, and being unable to escape, were destroyed wholesale. In the case of the locust in-

vasion of 1886 Brown reports (*vide* official report presented to both Houses of Parliament by Her Majesty, February 1887):—

“There were very few places where the locusts were sufficiently dense to justify the use of screens and traps, and they were in most cases destroyed by covering the ground they occupied by a thin layer of dry brushwood or rubbish and setting fire to it. By this means large areas were burned. Where the locusts were so sparsely scattered, or the scarcity of brushwood rendered this method inapplicable, they were destroyed by beating (an improved beater or locust flap of leather, weighted with lead, having been introduced by me this season). The weak point of these methods, as compared with the screen and trap system, is that, although the locusts may be greatly reduced, it is practically impossible absolutely to exterminate them, whereas our experience of 1883 and 1884 abundantly proved that when carefully worked it is possible, by the continuous screen system then first introduced, to completely clear large tracts of land where the locust swarms were most dense.”

Stauronotus maroccanus.—This insect, which is found in most of the countries bordering on the Mediterranean, and which has also been reported from Badghis in Afghanistan, has of late (1887—89) proved very destructive to grain crops in Eastern Algeria, where its increase has been favoured by drought. Unlike *Acridium peregrinum*, which periodically invades Algeria from the south, it breeds permanently on the sparsely-vegetated hill ranges in Algeria itself (Batna, M'lila, M'sila, Bordj, Rendir, &c.), and thence descends in countless numbers into the cultivated plains towards the shores of the Mediterranean. The invading flights appear in the summer, and the females proceed, on arrival, to deposit their eggs in holes about an inch deep, which they bore with their ovipositors in the ground. About thirty or forty eggs are deposited in a mass of mucilage in each hole. These eggs remain in the ground throughout the autumn and winter, and hatch in the following spring (eggs laid in the end of June and beginning of July 1888 hatched in April 1889). After hatching out, the young locusts band themselves together and march through the country devouring the crops. The loss occasioned in 1888 was estimated in the Consular report at about a million sterling. In 1888 measures were taken upon a large scale by the French Government for the destruction of the eggs, about 600,000 francs being said to have been expended in buying eggs, at the rate of 1 fr. 50 c. for two decalitres, from the Arabs. These measures, however, proved insufficient, and were considered unsatisfactory, M. Künckel d'Herculais indeed showing that whereas a man can rarely collect as much as 2.60 litres of egg cases, containing some 72,000 eggs, in a day, he can destroy about a million young locusts by collecting them after they have emerged from the eggs. In 1889, therefore, the Government introduced the Cyprus screen system upon a considerable scale for the destruction of the young locusts. About 300 kilometres of screen were procured and 100,000 people were employed in destroying the young

locusts. These measures seem to have been attended with considerable success, though definite information has not been received as to what extent the country was cleared of the pest¹.

Acridium peregrinum.—This is the chief locust of Northern Africa, Arabia, Persia, Baluchistan, and North-Western India. It has been fully dealt with in the report already issued.

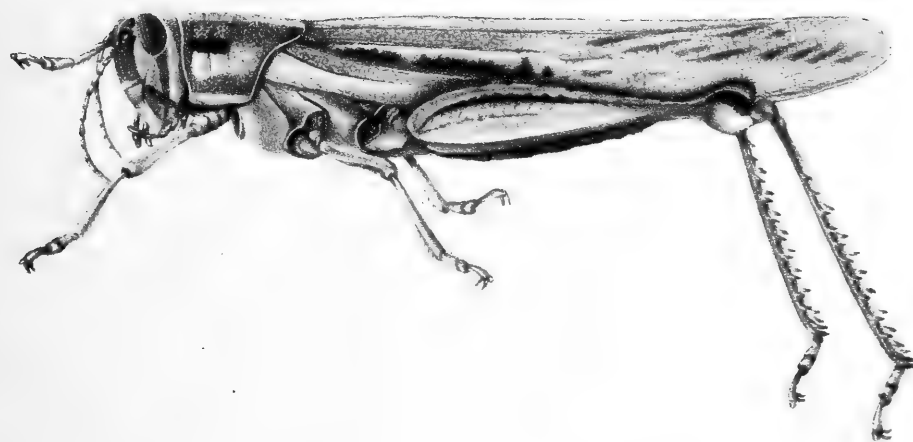
Acridium paranense has been described as the migratory locust of the Argentine republic, though some writers are of opinion that it may perhaps be the same as *Acridium peregrinum* (*vide* McLachlan: Encyclop. Brit., article *Locust*).

E. C. COTES,

13th May 1891.

Indian Museum.

¹ The above account is chiefly drawn from (1) Reports I and II by Mons. J. Künckel d'Herculais, dated May and August 1888; (2) Diplomatic and Consular Report on Agriculture in Algeria, No. 469; (3) Papers which have appeared in the *Illustrated London News*, *Le Mobacher* published in Algiers, and *Insect Life* published in Washington.



ACRIDIUM SUCCINCTUM LINN.

G.C.Chukraborty, del.

Photo-etching from the original Drawings - Survey of India Offices, Calcutta, August 1891.

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